EXHIBIT D

PUBLIC VERSION

EXHIBIT D

(Served July 1, 2021)

Qualcomm Infringing Products – Preliminary Infringement Claim Chart for U.S. Patent No. 7,346,313

The Qualcomm Infringing Products are any product made, used, sold, imported, and/or offered for sale in the United States by Qualcomm that includes a 5G Wireless Transceiver and/or an 802.11ax Wireless Transceiver. Based on information presently available to it, Red Rock contends that the Qualcomm Infringing Products include without limitation the products listed in Exhibit B. The Qualcomm Infringing Products also include any future 5G or later and/or 802.11ax or later products made, used, sold, imported, and/or offered for sale in the United States by Qualcomm.

Red Rock is informed and believes that each Qualcomm Infringing Product includes at least one 5G wireless transceiver and/or at least one 802.11ax wireless transceiver, implementing calibration systems and methods claimed by United States Patent No. 7,346,313 ("the '313 Patent").

Based on the information presently available to it, Red Rock contends that Qualcomm directly infringes the '313 Patent by making, using, selling, or offering to sell within the United States, or importing into the United States, Qualcomm Infringing Products implementing the claimed calibration systems and/or methods. Red Rock also contends that Qualcomm indirectly infringes the '313 Patent by actively inducing and contributing to its customers' direct infringement of the Asserted Claims.

Based on the information presently available to it, Red Rock contends that every Qualcomm Infringing Product performs I-Q gain imbalance calibration in an identical or substantially similar manner. Accordingly, the infringement theories and evidence disclosed in these contentions is exemplary of Red Rock's infringement theories and evidence for each and every Qualcomm Infringing Product, irrespective of which Qualcomm Transceiver it contains.

Red Rock contends that all Qualcomm 5G wireless transceivers and/or Qualcomm 802.11ax wireless transceivers perform I-Q gain imbalance calibration according to certain disclosures found in U.S. Patents assigned to Qualcomm, papers authored by Qualcomm personnel, third-party analyses of Qualcomm chips, and other additional evidence. Examples of relevant disclosures are cited herein.

CLAIM 7	ELEMENTS IN QUALCOMM INFRINGING PRODUCT
7[A]. A transceiver system comprising:	The Qualcomm Infringing Products comprise a transceiver system. As described above, each Qualcomm Infringing Product includes a Qualcomm 5G wireless transceiver and/or a Qualcomm 802.11ax wireless

transceiver.

The Qualcomm SDR865, SDX55M, and SMR526 chips comprise a transceiver system, both individually and collectively.

The SDR865 is a full-featured 5G platform:

5G

Staggering multi-gigabit speeds

The Snapdragon 865 is the most advanced 5G platform—ever. Designed to deliver unmatched connectivity and performance with peak speeds of up to 7.5 Gbps. Download, upload, stream and connect like never before. This platform is truly global so you can enjoy superior coverage and feel the power of 5G, all while maintaining unbelievable battery life.

- Supports all key regions and frequency bands including mmWave, sub-6, TDD, FDD and Dynamic Spectrum Sharing (DSS)
- Supports both standalone and non-standalone modes
- Supports global roaming and global multi-SIM

https://www.qualcomm.com/system/files/document/files/prod_brief_qcom_sd865_5g.pdf

SDR865 is a full-featured 802.11ax platform comprising the Qualcomm FastConnect 6800 Wi-Fi 6 subsystem:

Wi-Fi & Bluetooth

- Qualcomm® FastConnect™ 6800 Subsystem
  - Wi-Fi Standards: Wi-Fi 6 (802.11ax), 802.11ac Wave 2, 802.11a/b/g/n
  - Wi-Fi Spectral Bands: 2.4 GHz, 5 GHz
  - Peak speed: 1.774 Gbps
  - Channel Utilization: 20/40/80 MHz
  - 8-stream sounding (for 8x8 MU-MIMO)
  - MIMO Configuration: 2x2 (2-stream)
  - MU-MIMO (Uplink & Downlink)
  - 1024 QAM (2.4 & 5 GHz)
  - OFDMA (2.4 and 5 GHz)
  - Dual-band simultaneous (DBS)
  - Wi-Fi Security: WPA3-Enterprise, WPA3-Enhanced Open, WPA3 Easy Connect, WPA3-Personal

Id.

The SDR865 comprises the SDX55M modem-RF system chip:

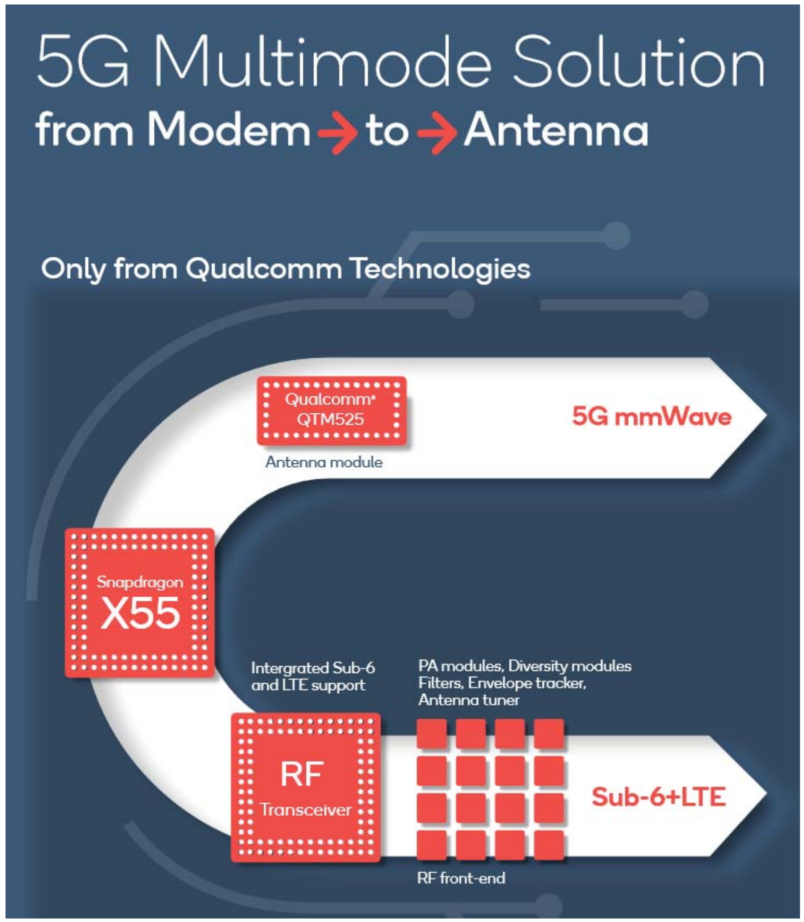
5G Modem-RF System

- Snapdragon X55 5G Modem-RF System
- 5G mmWave and sub-6 GHz, standalone (SA) and non-standalone (NSA) modes, FDD, TDD
- Dynamic Spectrum Sharing
- mmWave: 800 MHz bandwidth, 8 carriers, 2x2 MIMO
- Sub-6 GHz: 200 MHz bandwidth, 4x4 MIMO
- Qualcomm® 5G PowerSave
- Qualcomm® Smart Transmit™ technology
- Qualcomm® Wideband Envelope Tracking
- Qualcomm® Signal Boost adaptive antenna tuning
- Global 5G multi-SIM
- Downlink: Up to 7.5 Gbps
- Uplink: Up to 3 Gbps
- Multimode support: 5G NR, LTE including CBRS, WCDMA, HSPA, TD-SCDMA, CDMA 1x, EV-DO, GSM/EDGE

Id.

The SDX55M "is a comprehensive modem-to-antenna solution designed to allow OEMs to build 5G multimode devices." https://www.qualcomm.com/products/snapdragon-x55-5g-modem

As shown above, the SDX55M supports 4x4 MIMO, which means it is a transceiver and it must contain at least four transmit chains and at least four receive chains.

	As shown above, the FastConnect 6800 supports 8x8 MU-MIMO, which means it is a transceiver and it must contain at least eight transmit chains and at least eight receive chains The SDX55M interfaces with one or more RF transceiver and/or RF front-end modules, such as the QTM525 and/or the SMR526, to form a transceiver system. 

Tech Insights performed an RF architecture analysis of the Qualcomm SMR526 RF Transceiver. That Report shows, for example, that the SMR 526 is part of a transceiver system:

Package

Manufacturer	Qualcomm
Part Number	SMR526
Description	RF Transceiver
Package Type	BGA GENERIC (Ball Grid Array)
Package Pin Count	135
Package Markings (top)	SMR526 001 JE943 98G
Standard Date Code	NA

Die

Manufacturer	Qualcomm
Part Number	HG11-PG661-200
Die markings	QUALCOMM HG11-PG661-200
Die Size	3.82 mm × 4.69 mm = 17.92 mm^2
Number of Metal Levels	8
Number of Poly Levels	1

Tech Insights: RF Architecture Analysis of the Qualcomm SMR526 RF Transceiver, Report ID#: ARC-2005-801 at v (hereinafter "TechInsights").

Qualcomm and the industry as a whole recognize the essential need for I-Q gain imbalance calibration in 5G wireless transceivers.

In an academic paper that "was supported by Qualcomm Inc." the authors wrote:

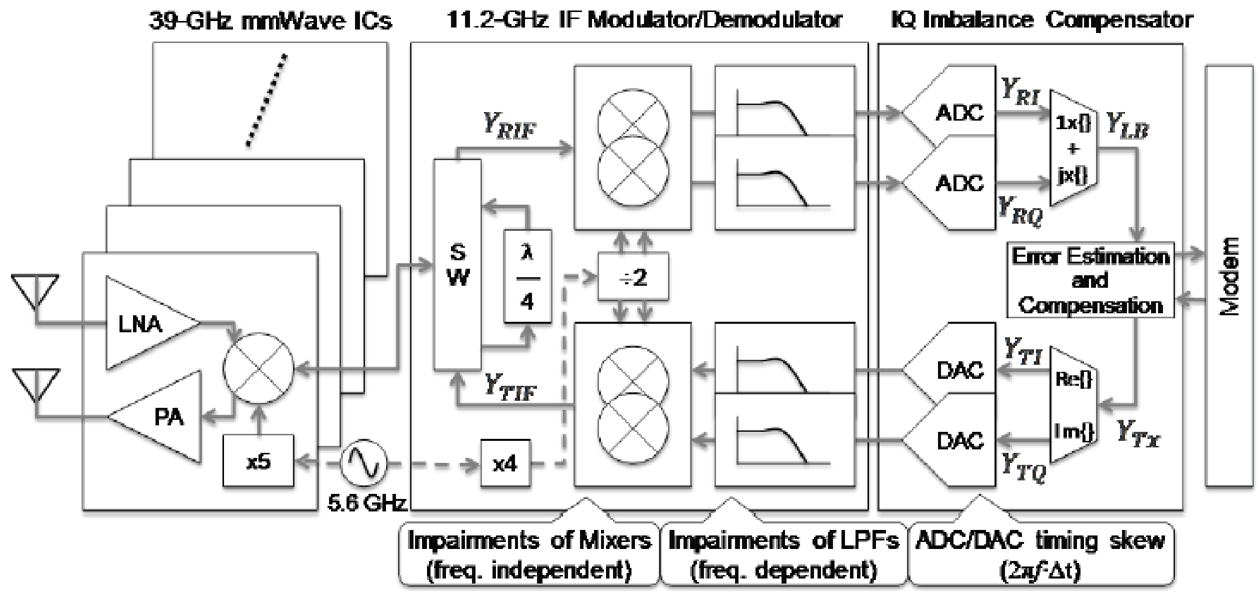
	At present, existing commercial standards in the RF bands (1–6 GHz), such as wideband code division multiple access, local thermal equilibrium, and Wi-Fi, provide as much as 160-MHz BW with data rates as high as 1000 Mb/s per user. The demand for more accessible BW and higher data rate is predicted to grow as the next-generation communication systems; that is, 5G is expected to support 1000 times higher data per area, and 10–100 times higher data rates per user (10–100 Gb/s) with as much as 10× extension in battery life compared to existing solutions. The RF spectrum, in the 1–6-GHz band, has become increasingly crowded with incremental improvements in spectral efficiency through higher order signal modulation schemes, e.g., 1024 QAM. … utilizing a direct-conversion architecture to realize a mm-wave transceiver requires I–Q signals that are highly phase accurate (90°), with a minimal amplitude mismatch. T Zhang, et al., "A Precision Wideband Quadrature Generation Technique With Feedback Control for Millimeter-Wave Communication Systems," IEEE TRANSACTIONS ON MICROWAVE THEORY AND TECHNIQUES, Vol. 66, No. 1 at 215 (Jan. 2018). 3GPP TS 38.101-1 (*see, e.g.*, version 15.2.0 Release 15 at section 6.4.2.1) specifies minimum EVM requirements for various 5G modulation schema: The RMS average of the basic EVM measurements for 10 sub-frames excluding any transient period for the average EVM case, and 60 sub-frames excluding any transient period for the reference signal EVM case, for the different modulations schemes shall not exceed the values specified in Table 6.4.2.1-1 for the parameters defined in Table 6.4.2.1-2. For EVM evaluation purposes, all PRACH preamble formats 0-4 and all PUCCH formats 1, 1a, 1b, 2, 2a and 2b are considered to have the same EVM requirement as QPSK modulated. **Table 6.4.2.1-1: Requirements for Error Vector Magnitude** Parameter / Unit / Average EVM Level: Pi/2-BPSK / % / 30 QPSK / % / 17.5 16 QAM / % / 12.5 64 QAM / % / 8 256 QAM / % / 3.5 The Qualcomm Infringing Products and their Qualcomm 5G wireless transceivers are required to meet or exceed these minimum EVM levels. On information and belief, it is standard industry practice to

Table 6.4.2.1-1: Requirements for Error Vector Magnitude

Parameter	Unit	Average EVM Level
Pi/2-BPSK	%	30
QPSK	%	17.5
16 QAM	%	12.5
64 QAM	%	8
256 QAM	%	3.5

	exceed these minimum requirements by 2dB or more, in order to ensure compliance across manufacturing tolerance ranges. These requirements cannot be achieved without performing I-Q gain imbalance calibration. On information and belief, there are no acceptable non-infringing alternatives to the ’313 Patent that would enable compliance with these requirements. Qualcomm’s US App. No. 2020/0029345 also recognizes the need for calibration in 5G chips: **[0014]** Future wireless network deployments may present increased calibration requirements on wireless devices. For example, new high frequency millimeter wave bands for 5G-NR may have additional regulatory restrictions pertaining to radiation exposure to humans, which may be known as Maximum Permissible Exposure (MPE). Additionally NR is expected to adopt several advanced transceiver algorithms/architectures. Some of these are expected to require calibrations to eliminate or reduce common impairments imposed by various elements in the transceiver chain. It may be desirable in some cases to perform various measurement operations, such as measuring a distance to nearby objects or human tissues or performing device internal calibrations, in-band by leveraging existing componentry on the device. Using existing antennas and transceiver chains for making such measurements may lead to advantages such as reduced device cost, power consumption, and better device form-factor. However, using existing componentry may lead to conflicts in terms of usage of said componentry for (a) mission-mode operations such as wireless communication and (b) for measurements or calibration procedures. In general it may be advantageous to perform these measurements or calibrations in a manner that does not impede or impair regular transmit/receive operations required by a wireless protocol, such as the 5G-NR specifications. A paper authored by Samsung engineers Aoki et al. recognizes the need for I-Q calibration in 5G wireless transceivers: “IQ imbalances generate an unwanted image signal in the inversed-sign side of the baseband frequency. The image signal degrades the signal-to-noise ratio (SNR), and consequently, causes degradation in the error vector magnitude (EVM). 5G supports 256 QAM which requires an average EVM of −29.1 dB (3.5%). The image-rejection ratio (IRR) must be significantly larger than

29.1 dB." Aoki et al., 1.4-GHz Bandwidth Frequency-Dependent I/Q Imbalance Calibration for 5G mmWave Communications, 2019 IEEE/MTT-S International Microwave Symposium at 626. This paper also proposes a loopback-based calibration system to address these I-Q gain imbalances:



"This paper presents a frequency-dependent inphase and quadrature-phase (IQ) imbalance calibration technique for ultra-wide bandwidth 5G millimeter-wave communication chipsets. Using a multi-tone training signal and a phase shifter inserted in the **transceiver local loopback path**, the transmitter and receiver IQ imbalances can be estimated separately." *Id.* (emphasis added).

A Qualcomm employee named Afsaneh Nassery authored a paper championing the importance of loopback I-Q gain imbalance calibration: "We propose a self-test method for zero-IF radio frequency transceivers **using primarily loopback**, aided by a small built-in self-test (BIST) circuitry, to determine critical performance parameters, such as **I/Q imbalance** and nonlinearity coefficients." Nassery et al., Built-In Self-Test and Digital Calibration of Zero-IF RF Transceivers, IEEE TRANSACTIONS ON VERY LARGE SCALE INTEGRATION (VLSI) SYSTEMS at 1 (emphasis

	added) (hereinafter "Nassery"). Qualcomm and the industry as a whole recognize the essential need for I-Q gain imbalance calibration in 802.11ax wireless transceivers. The 802.11ax (Wi-Fi 6) standard imposes even more stringent EVM requirements than the 5G standard. Therefore, I-Q gain imbalance calibration is necessary to meet the requirements of the Wi-Fi 6 standard for the same reasons that such calibration is necessary to meet the requirements of the 5G standard:

Table 27-49—Allowed relative constellation error versus constellation size and coding rate

Modulation		Coding rate	Relative constellation error in an HE SU PPDU, HE ER SU PPDU and HE MU PPDU (dB)	Relative constellation error in an HE TB PPDU when transmit power is larger than the maximum power of HE-MCS 7 (dB)	Relative constellation error in an HE TB PPDU when transmit power is less than or equal to the maximum power of HE-MCS 7 (dB)
Without DCM	With DCM				
N/A	BPSK	1/2	–5	–13	–27
BPSK	QPSK	1/2	–5	–13	–27
QPSK	16-QAM	1/2	–10	–13	–27
QPSK	16-QAM	3/4	–13	–13	–27
16-QAM	N/A	1/2	–16	–16	–27
16-QAM	N/A	3/4	–19	–19	–27
64-QAM	N/A	2/3	–22	–22	–27
64-QAM	N/A	3/4	–25	–25	–27
64-QAM	N/A	5/6	–27	–27	–27
256-QAM	N/A	3/4	–30	–30	–30
256-QAM	N/A	5/6	–32	–32	–32
1024-QAM	N/A	3/4	–35/–32	–35/–32	–35/–32
1024-QAM	N/A	5/6	–35/–32	–35/–32	–35/–32

NOTE—The maximum power of HE-MCS 7 can be measured by setting the UL Target RSSI subfield as defined in Table 9-29j (UL Target Receive Power subfield in Trigger frame) in the Trigger frame to 127 for the RU for which the EVM test is conducted.

For 1024-QAM, the relative constellation error shall meet either one of the following requirements:

— The relative constellation error shall be less than or equal to –35 dB if amplitude drift compensation is disabled in the test equipment

— The relative constellation error shall be less than or equal to –35 dB with amplitude drift compensation enabled in the test equipment, and the relative constellation error shall be less than or equal to –32 dB with amplitude drift compensation disabled in the test equipment

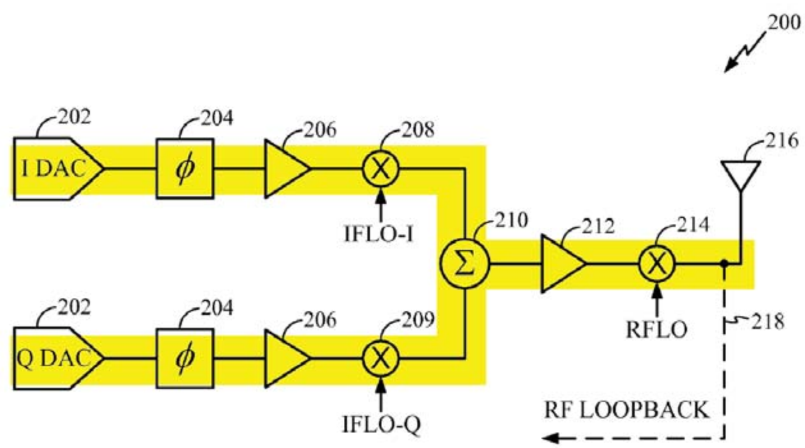
See IEEE P802.11ax/D8.0 at 678; *see also* IEEE 802.11ax-2021 at 636 (Table 27-49).

The Qualcomm Infringing Products and their Qualcomm 802.11ax wireless transceivers are required to meet or exceed these minimum EVM levels. On information and belief, it is standard industry practice to exceed these minimum requirements by 2dB or more, in order to ensure compliance across manufacturing tolerance ranges. These requirements cannot be achieved without performing I-Q gain imbalance calibration. On information and belief, there are no acceptable non-infringing alternatives to the ’313 Patent that would enable compliance with these requirements.

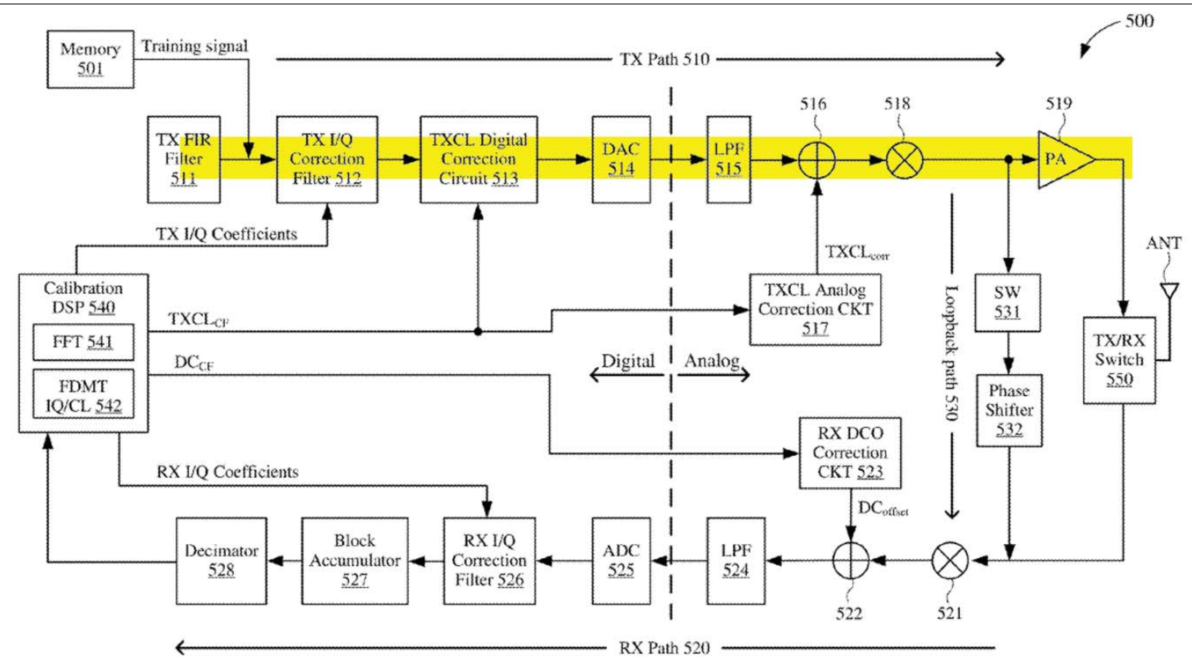
<table>
<tr><td></td><td>Red Rock alleges that the Qualcomm Infringing Products perform I-Q gain imbalance calibration in the manner recited in one or more of several Qualcomm patents and other documents, cited herein. Each of these I-Q calibration techniques infringes the ’313 Patent, as shown below.</td></tr>
<tr><td>7[B] a transmit chain including: a signal generator for generating a baseband transmit signal; baseband I-Q amplification subsystem for providing baseband amplification of the baseband transmit signal; a direct-conversion subsystem for converting the baseband transmit signal to an RF transmit signal, and an RF transmit signal port;</td><td>The Qualcomm Infringing Products include a transmit chain.

See 7[A] above.

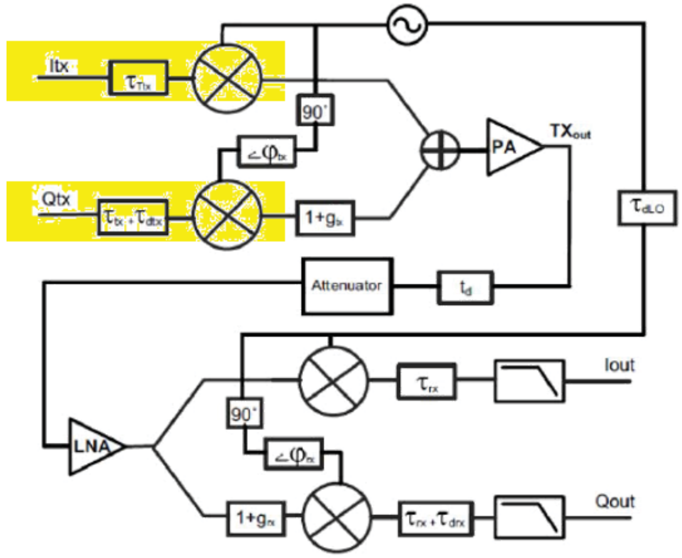
Transmit chains are highlighted in yellow in the figures below.

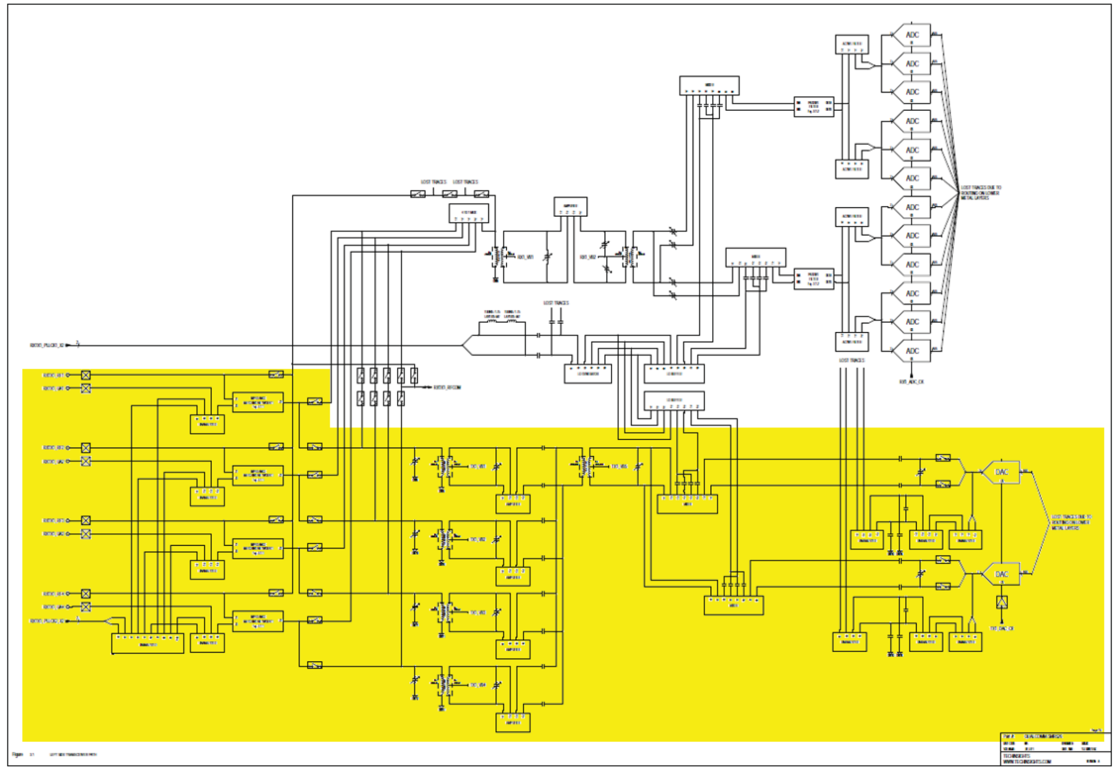


U.S. Pat. No. 8,478,222 (“’222 Patent”) at Fig. 2A.</td></tr>
</table>



U.S. Pat. No. 10,116,485 (“’485 Patent”) at Fig. 5; *see also id.* at Fig. 2.

	 Fig. 1. Transceiver system block diagram. Nassery at 2.



TechInsights at 16 (illustrating portions of transmit chain); *see also id.* at 19 (same); *see also id.* at 1 ("The schematics in this report use single lines for multi-wire (such as differential, ***quadrature***, multi-phase etc..) signals.") (emphasis added).

The transmit chain includes a signal generator for generating a baseband transmit signal:

Referring first to the transmitter **200**, in phase (I) and quadrature (Q) signals are generated that are 90 out of phase relative to each other. The initial signal amplitudes may be controlled by digital to analog converters **202**. The relative phase of the I/Q signals may be controlled by adjustable phase rotators **204**, and the I/Q signals may be amplified by adjustable gain stages **206**.

’222 Patent at 5:29-35.

The transmitter **210** is coupled to one or more antennas **202**, and includes a transmitter analog front-end (AFE) **220** and a transmitter baseband processor **240**. The transmitter baseband processor **240** includes a transmitter pre-distortion unit **245**. For the in-phase (I) signal path, the transmitter

’485 Patent at 7:11-15.

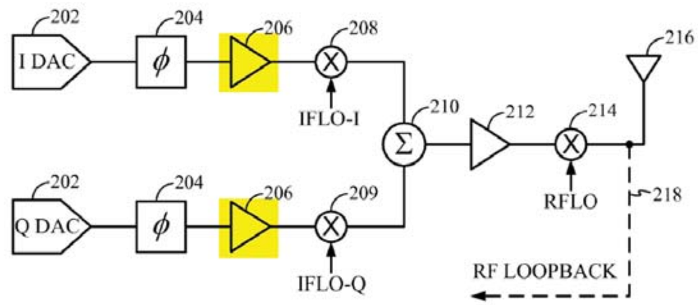
In some implementations, a memory **501** may store one or more training signals that, when transmitted through the calibration path **500**, may be used by a calibration DSP **540** to estimate transmitter I/Q imbalances, receiver I/Q imbalances, and transmit carrier leakage of the transceiver. The

’485 Patent at 17:44-48.

“Fig. 2 shows the defined test signals, which can easily be **generated by on-chip digital resources (e.g., the DSP)**. Dividing the test signal into two phases and exciting one arm at a time with a simple sinusoidal signal are the first step in decoupling various internal parameters.”

Nassery at 3.

The transmit chain includes a baseband I-Q amplification subsystem for providing baseband amplification of the baseband transmit signal:



’222 Patent at Fig. 2A.

Referring first to the transmitter **200**, in phase (I) and quadrature (Q) signals are generated that are 90 out of phase relative to each other. The initial signal amplitudes may be controlled by digital to analog converters **202**. The relative phase of the I/Q signals may be controlled by adjustable phase rotators **204**, and the I/Q signals may be amplified by adjustable gain stages **206**.

’222 Patent at 5:29-35.

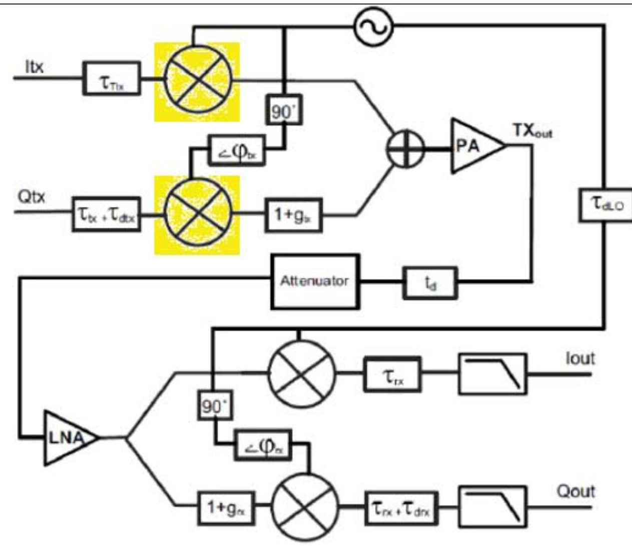
and receiver I/Q imbalances. Because the transmit DC offset μ_r is a complex number representing the transmit DC offset as seen from the baseband frequency domain, there may be a scaling factor K_f between μ_r and the TXCL correction point in the transceiver. In some implementations, the scaling factor may depend on a gain of the transmit path **510** of the transceiver.

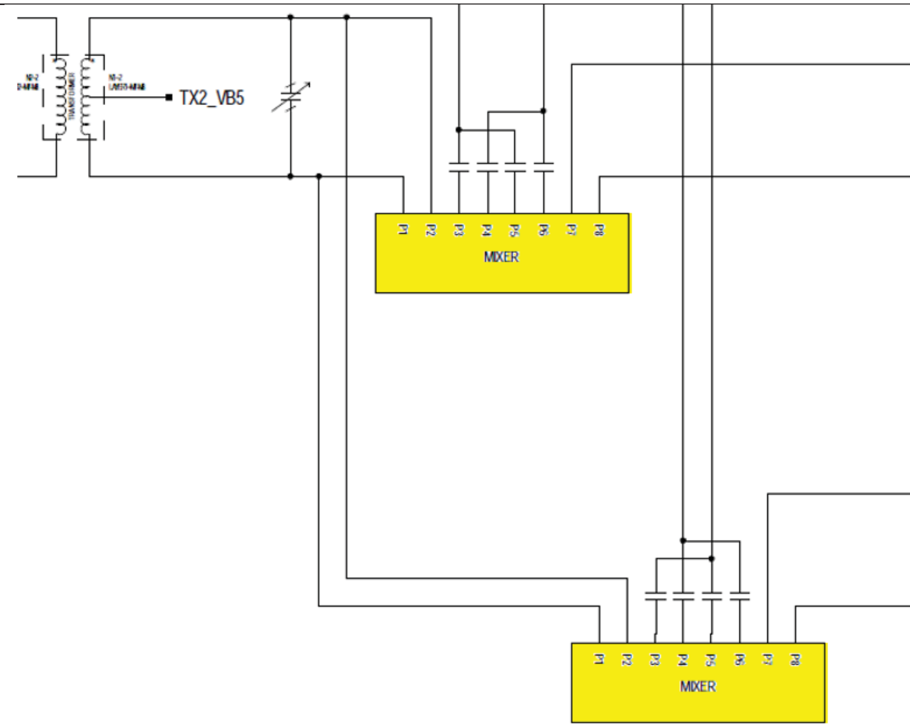
’485 Patent at 21:26-32.

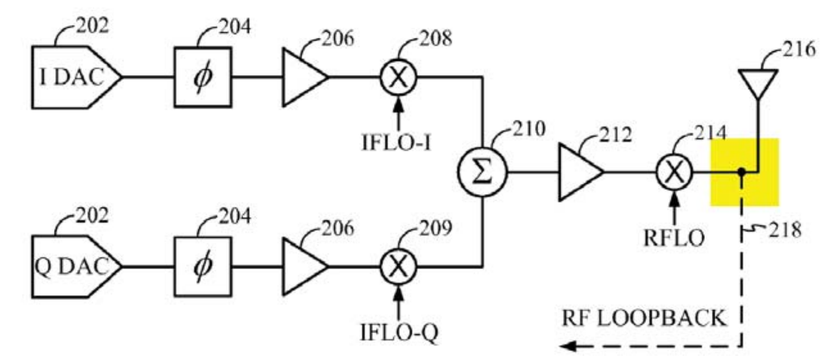
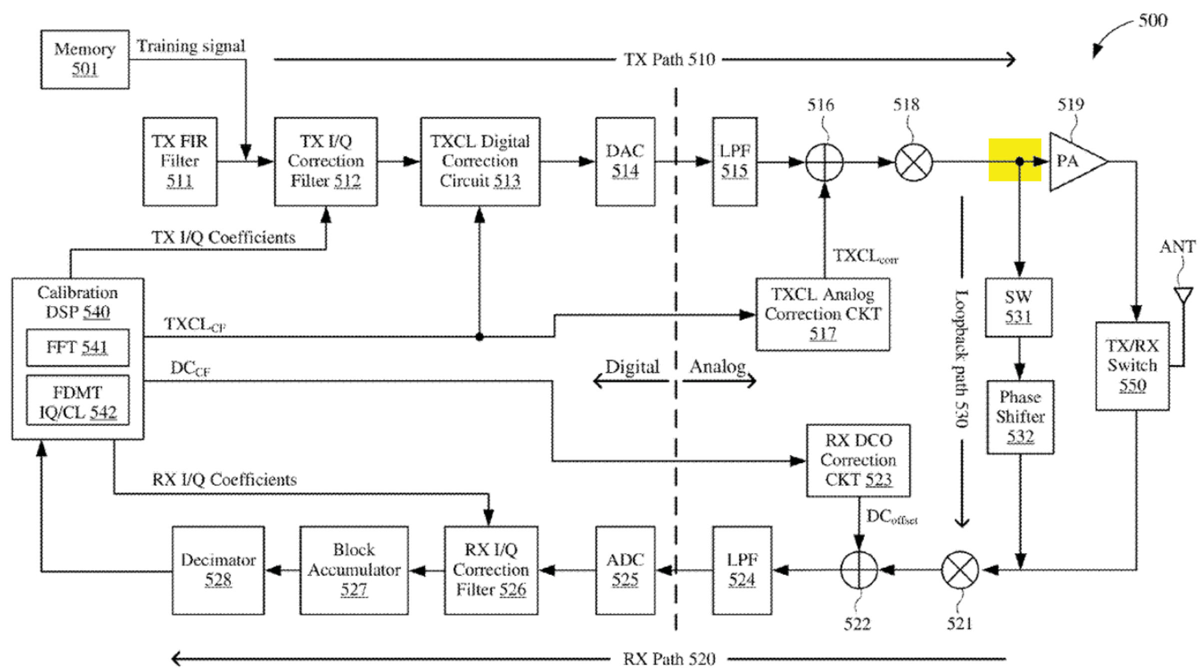
The transmit chain includes a direct-conversion subsystem for converting the baseband transmit signal to an RF transmit signal.

	While the transmitter and receiver of FIGS. **2**A and **2**B are illustrated separately, they can be combined into one transceiver unit. Further, for further generality, the dual stage transmitter and receiver shown can include more or fewer stages. For example, a direct or zero intermediate frequency (ZIF) radio demodulation technique may be used with certain embodiments, where a ZIF does not use an intermediate frequency, but utilizes only one mixer stage to convert the desired signal directly to and from the baseband without any IF stages. '222 Patent at 5:55-64. The transmit path **510** may include a transmit finite impulse response (FIR) filter **511**, a TX I/Q correction filter **512**, a TXCL digital correction circuit **513**, a DAC **514**, a LPF **515**, a summer **516**, a TXCL analog correction circuit **517**, a modulator **518**, and a power amplifier (PA) **519**. The TX I/Q correction filter **512** may compensate for signal impairments caused by transmitter I/Q imbalances in the time domain portion of the transmit path **510** based on one or more transmitter I/Q imbalance correction filter coefficients determined by the calibration DSP **540**. In some implementations, the TX I/Q correction filter **512** may use the determined transmitter I/Q imbalance correction filter coefficients to pre-correct for transmitter I/Q signal impairments. '485 Patent at 18:26-39.

	The transmitter **210** is coupled to one or more antennas **202**, and includes a transmitter analog front-end (AFE) **220** and a transmitter baseband processor **240**. The transmitter baseband processor **240** includes a transmitter pre-distortion unit **245**. For the in-phase (I) signal path, the transmitter AFE **220** includes a digital-to-analog converter (DAC) **221**A, a filter **222**A, and a local oscillator (LO) mixer **224**A. For the quadrature (Q) signal path, the transmitter AFE **220** includes a DAC **221**B, a filter **222**B, an LO mixer **224**B, a variable gain amplifier (VGA) **226**, and a power amplifier (PA) **228**. The mixer **224**A up-converts an in-phase (I) transmit signal from baseband directly to the carrier frequency by mixing the I transmit signal with an in-phase transmit local oscillator signal $LO(I)_{TX}$, and the mixer **224**B up-converts a quadrature (Q) transmit signal from baseband directly to the carrier frequency by mixing the Q transmit signal with a quadrature transmit local oscillator signal $LO(Q)_{TX}$. The frequency of the transmit LO signals $LO(I)_{TX}$ and $LO(Q)_{TX}$ is ideally the carrier frequency. A combiner '485 Patent at 7:11-29.

	 Fig. 1. Transceiver system block diagram. Nassery at 2.

	 TechInsights at 16; *see also id.* at 19. The transmit chain includes a RF transmit signal port. A RF transmit signal port is provided at or after the transmit RF mixer and at or before the antenna:

	 ’222 Patent at Fig. 2A. The transmit signal port in Figure 2A is located between transmit mixers (214) and the antenna (216).  ’485 Patent at Fig. 5; *see also id.* at Fig. 2 (same).

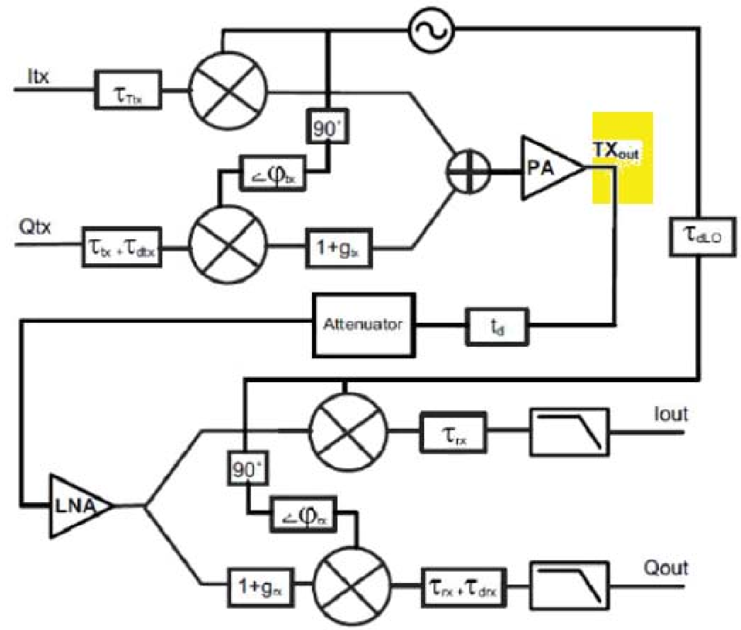
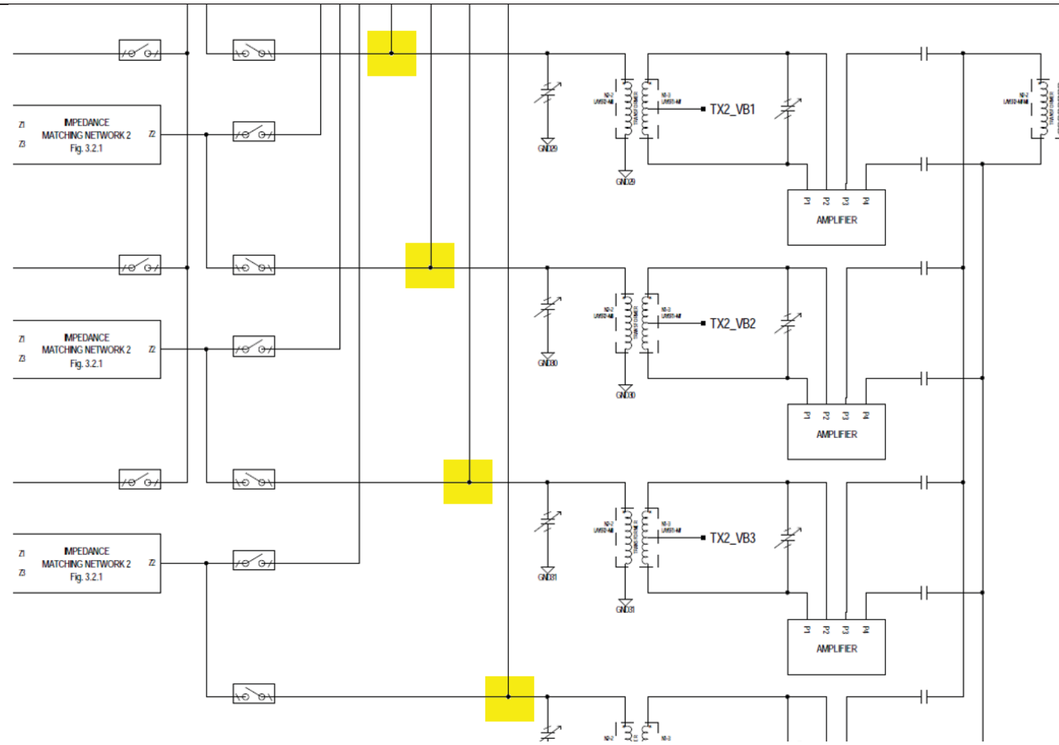


Fig. 1. Transceiver system block diagram.

Nassery at 2.

	 TechInsights at 16; *see also id.* at 19.
7[C] a receive chain including: an RF receive port for receiving an RF receive signal; a direct-conversion subsystem for converting the RF receive signal to a baseband receive signal; a baseband I-Q amplification subsystem for providing	The Qualcomm Infringing Products include a receive chain. *See* 7[A] above. Receive chains are highlighted in yellow in the figures below.